AQUATIC HABITAT VALUATION BASED ON FISHERY VALUES
AND APPLIED TO RANGELAND MANAGEMENT

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INTRODUCTION

Management of Forest rangelands is a very complex and recently contro-
versial science. Not only does management of rangeland resources
have to consider implications of soil characteristics, geomorphology,
vegetative types, climate and rainfall conditions, management has to
consider competing resource values that may exist on the unit of
rangeland to be managed. Past rangeland management concentrated a
majority of time and effort on developing programs designed to maximize
the grazing resource component with a minimum of imput from other
resources. This condition however, is fast changing and the land
manager is being faced with adjustment of rangeland management programs
to include recognition of other resources, such as minerals, recreation,
wildlife and fish.

Coordination between the various rangeland resources has increased in
difficulty as user groups have demanded more diversified rangeland
benefits. Decisions to increase the outputs of one resource often
leads to reduction of others. Forest rangelands are, in many cases,
not able to supply the needs and wants of all competing users and the
land manager is faced with deciding which benefits (both market and
non-market) will receive priority status. These decisions on allocation
of resources and the subsequent management of rangeland resources are
guided by public needs and desires for goods and services. The
comparative importance of the competing goods and services desired
from rangelands are often based on benefit-cost criterion. Congressional
direction expressed in the National Environmental Policy Act, Resources
Planning Act, and National Forest Management Act has included economic
analyses as part of total resource administration.

The intent of this report is to provide land managers with an initial
exposure to application of economic values associated with the aquatic
resource. This exposure should aid in preparing a clearer picture of
resource values and in making more satisfactory land management
decisions.

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1 Cooperative Education Graduate Student - Management Economics

Fishery resources, in many cases, have not received adequate representation during the decision-making process. This can be related to the difficulty in determining adequate economic values for fish populations and the habitats they are dependent upon. Examples of fishery resource oversight are evident throughout the country with many high value fisheries being subjected to adverse impacts from another resource development because economic values associated with the fishery were not readily available in the decision-making process. To correct this inadequacy, economists and fishery biologists have recently devoted much time to developing procedures by which suitable evaluation of fishery resource values can be represented in the decision-making process. Problems associated with putting a dollar value on fishery resources are related to the fact that many fishery values are not directly comparable with other commodity resources whose values are determined at the market place. Use of values based on total expenditures for individuals utilizing the fishery resource can produce erroneous results (Everest, 1977). It is obvious that total expenditures by fishery resource uses do not represent the value of the resource, neither are they comparable to benefits generated by other resource based industries (Brown et al, 1964; Everest 1977). To relate the value of a fishery resource to the expenditure of the users would be similar to evaluating the worth of an allotment to the expenditures of the rancher utilizing it.

Recent procedures have been designed to develop so-called "shadow prices", which are value estimates of what prices would be if there had been free trading in a competitive market (Clawson, 1976). To develop these values, two techniques have been utilized, both required the use of questionaires. One method utilizes a demand function related to the value of use or willingness to pay for fishing opportunities (Brown et al, 1964; Gordon et al, 1973). The other approach (Mathews and Brown, 1970) was based on a willingness to sell a fishing right for a period of one year. The willingness to sell approach eliminated much of the bias generated by the fear that license fees could increase to a level commensurate with the willingness to pay. A similar response would likely be expected from permittees if they were confronted with questionnaires concerning willingness to buy or sell allotment rights.

Hansen (1977) discusses the methodology and utilization of wildlife values applicable to the Intermountain Region of the Forest Service expressed in terms of social output-user days, RVD (recreation visitor day). The determined value (Table 1) for an RVD is based on total willingness to purchase (pay) and includes the actual cost of the day to the user and any additional expenditure the user is willing to pay to be able to participate in a day of activity. In the case of

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TABLE 1. -- Angler-Day values derived from "willingness to pay" surveys conducted for anadromous and resident species.

Geographical Area	Species	Value per Angler-Day	Reference
Oregon[1]	Salmon-Steelhead	$20	Brown et al (1972)
Washington	Salmon	$32-$63	Mathews & Brown (1970)
Columbia River	Salmon-Steelhead	$28	Tuttle et al (1975)
	Salmon-Steelhead	$51	Tuttle (1979)[2]
Idaho	Salmon-Steelhead	$25	Gordon et al (1973)
	Resident Trout	$10	Gordon et al (1973)
Region IV USFS[3, 4]			
	Salmon-Steelhead	$30	Hansen (1977)
	Resident Coldwater	$20	Hansen (1977)

1 Values are for both freshwater and marine sport fisheries.

2 Personal communication Mr. Merrit Tuttle, National Marine Fisheries Service, Portland, Oregon.

3 Includes Utah, Nevada, and parts of Idaho, Wyoming, Colorado, and California.

4 Values are based on a 12-hour visitor day as opposed to an angler day which may be a shorter unit of time.

anadromous fish of commercial value another important value parameter is value per pound of catch. These values are based on commodity pricing on active open markets.

ANADROMOUS FISHERY ECONOMICS

Application of these user oriented values to actual valuation of fishery resources has been tested by a number of individuals (Everest, 1975; Everest 1977; Mathews and Brown, 1970; Tuttle et al., 1975; Brown et al, 1972). With few exceptions (Kunkel and Janik, 1976; Gordon et al, 1973) these studies have been limited to valuation of fisheries characterized by anadromous species (species utilizing both fresh and salt water environments). Fisheries characterized by resident species (remain in fresh water during entire life) present special problems because in many cases exploitation is far below the potential of the fisheries to provide angling opportunity.

Valuation of anadromous fishery resources is compounded by a number of variables, one of which is harvest distribution. Harvest distribution can be broken down into several distinct units: marine sport harvest, freshwater sport harvest, marine commercial harvest, freshwater commercial harvest, and Indian harvest. Distribution of harvest within these units will vary between fish species. Other variables of significance are rate of catch, average size (weight), and catch to escapement ratio. Valuation of inland habitat areas are closely tied to the value of escaping adults because these habitats provide the spawning and rearing habitats necessary to sustain downstream fishery demands. Statistics used in deriving anadromous fish values are presented in Table 2. For the sake of continuity, the values expressed in Tuttle et al. (1975) for anadromous fisheries will be used in the economic discussions of this report. (Figures 1 and 2).

Application of the escapement value to forest aquatic resources would be related to habitat available to provide suitable spawning and rearing areas. A specified amount of suitable spawning habitat can be expected to accommodate a maximum number of spawning adults. The same reasoning applies to the amount of rearing habitat needed to provide suitable habitat for the offspring of spawning adults. At present, habitat utilization by anadromous species is generally below potential in the interior reaches of the Columbia River drainage. This reduction in habitat use is closely associated with downstream passage problems. Present habitat quantity, in inland areas is ample in most cases. There is, however, a need to protect habitat quality to insure optimization of existing run levels.

TABLE 2. -- Parameters Important in Determining Net Economic Worth of Anadromous Fish Species.

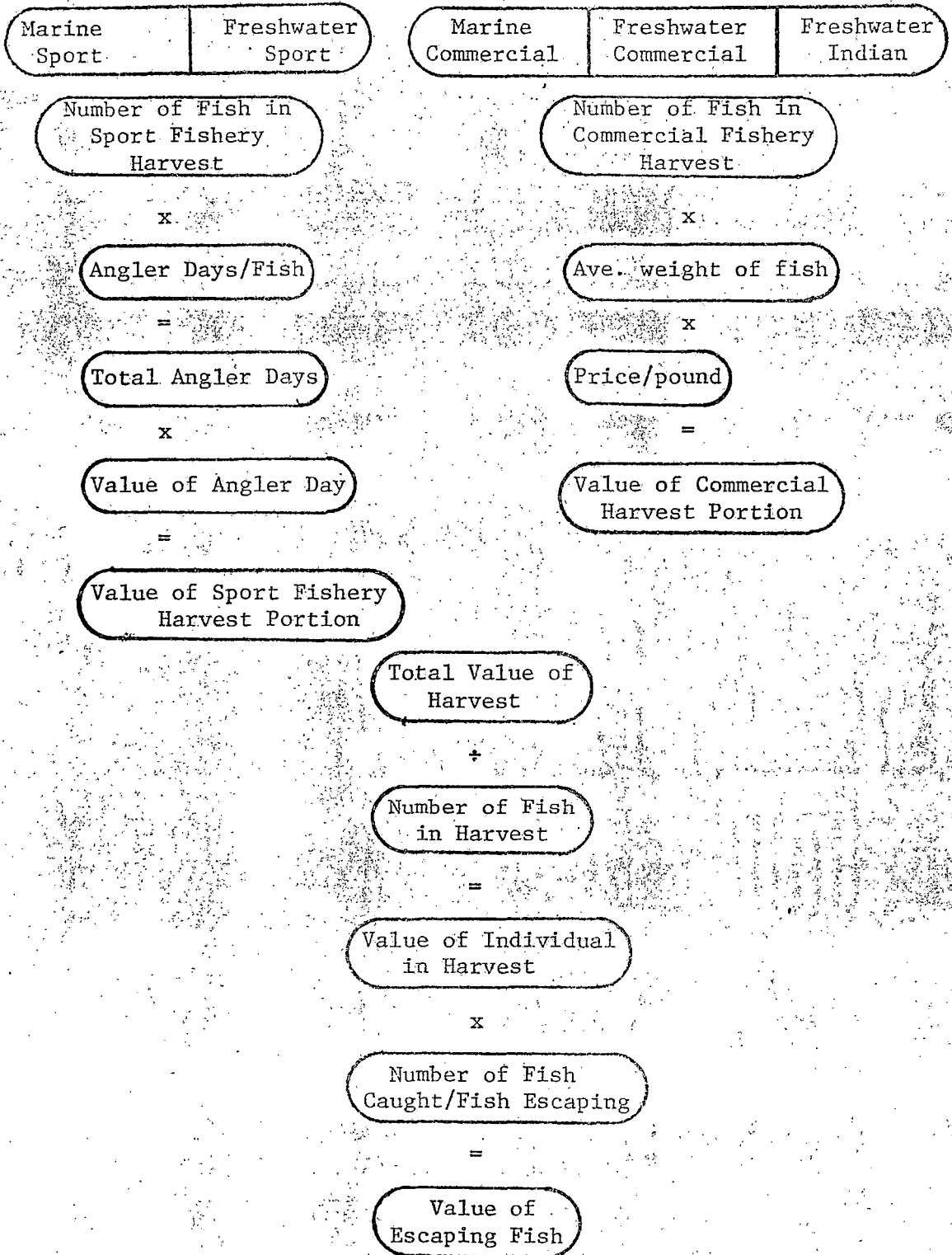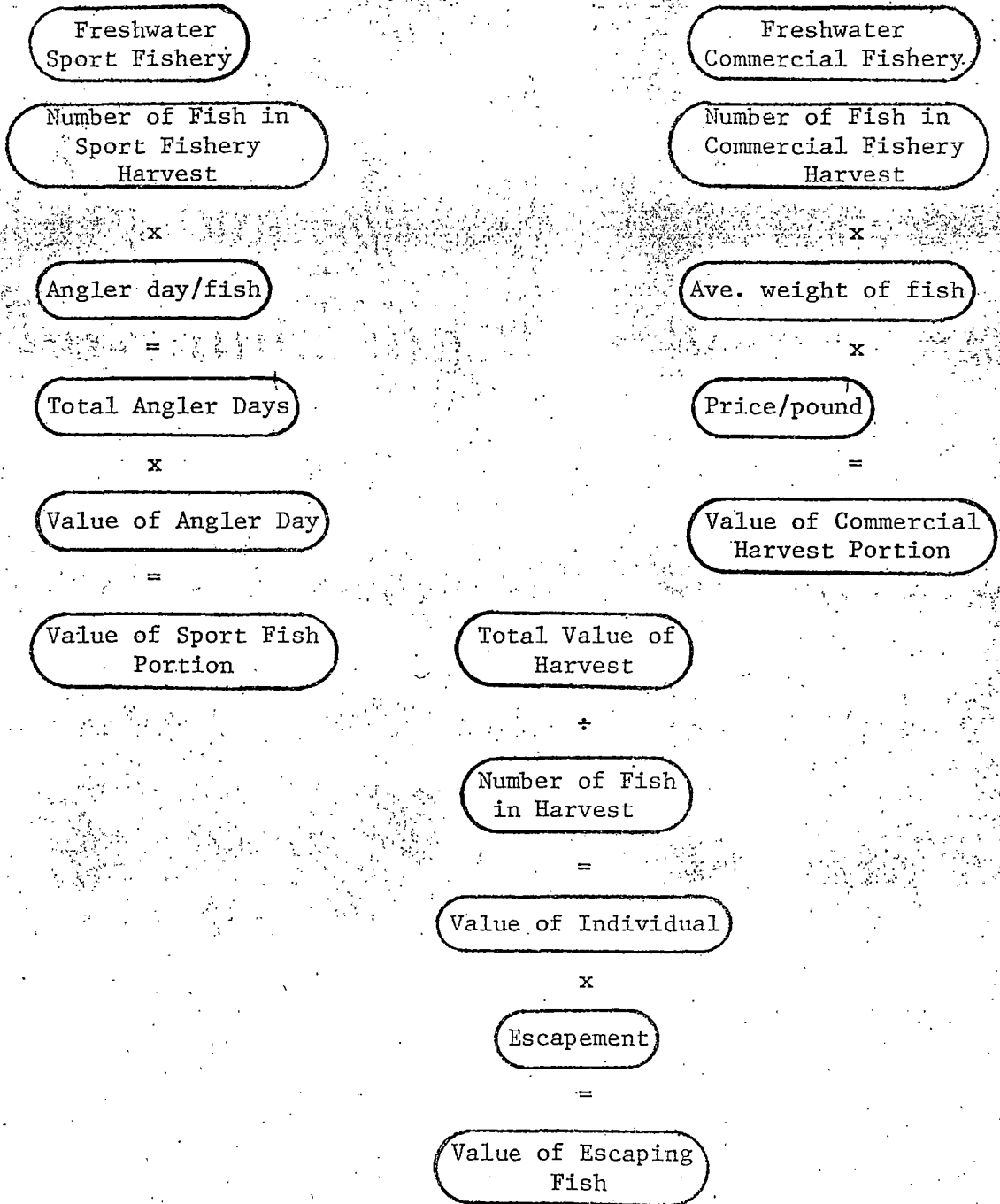| Fishing Parameter	Salmon	Steelhead	Reference
Catch/escapement ratio	2-5/1	0.5/1	Daily (1975)
	5/1	0.5/1	Kunkel & Janik (1976)
	2/1	1.5/1	Tuttle et al (1975)
Division of Catch (Sport/Commercial)	.275/.725	-	Kunkel & Janik (1976)
	.46/.54	.78/.22	Tuttle et al (1975)
Angler Days/Fish	1.2-4.8/1	-	Sayre (1972)
	5/1	4.5/1	Tuttle et al (1975)
	3.3/1	4/1	Kunkel & Janik (1976)
Average Weight per Commercially Valued Fish (Pounds)	14	10	Tuttle et al (1975)
	10.2	-	Kunkel & Janik (1976)
	10.4	-	Reed et al (1975)
Average Value/Pound of Commercially Valued Fish	1.05	-	Kunkel & Janik (1976)
	0.99	0.55	Tuttle et al (1975)

FIGURE 1

Salmon

Harvest Distribution

| Marine Sport | Freshwater Sport | | Marine Commercial | Freshwater Commercial | Freshwater Indian |

Number of Fish in Sport Fishery Harvest

x

Angler Days/Fish

=

Total Angler Days

x

Value of Angler Day

=

Value of Sport Fishery Harvest Portion

Number of Fish in Commercial Fishery Harvest

x

Ave. weight of fish

x

Price/pound

=

Value of Commercial Harvest Portion

Total Value of Harvest

÷

Number of Fish in Harvest

=

Value of Individual in Harvest

x

Number of Fish Caught/Fish Escaping

=

Value of Escaping Fish

FIGURE 2

Steelhead

Harvest Distribution

Freshwater Sport Fishery

Number of Fish in Sport Fishery Harvest

x

Angler day/fish

=

Total Angler Days

x

Value of Angler Day

=

Value of Sport Fish Portion

Freshwater Commercial Fishery

Number of Fish in Commercial Fishery Harvest

x

Ave. weight of fish

x

Price/pound

=

Value of Commercial Harvest Portion

Total Value of Harvest

÷

Number of Fish in Harvest

=

Value of Individual

x

Escapement

=

Value of Escaping Fish

7

Very little has been done concerning valuation of resident fish. Kunkel and Janik (1976) in their evaluation of fishery economics on the Siuslaw National Forest calculated economic worth by multiplying the angler-days by the net economic value of an angler-day. The value of the angler-day used was $10.60 per day (Gordon et al, 1973). Application of this approach (Figure 3) would be dependent upon having a reliable creel census describing angler use characteristics for the aquatic habitat of concern. It should be pointed out that many resident fisheries sustain useage far below the fish populations capacity to support use. Valuation based on these reduced levels, will in many cases, produce underestimates of value.

As an alternative to using creel census information, the following methods are proposed to compensate for the reduced levels of use. The first and preferred method would be based on fish population structure of a given fishery and the population's ability to support angling at a reasonable rate of return to the creel. Information needed to complete the valuation include: population estimate of harvestable-sized fish, percentage of the harvestable-sized fish which could be harvested, and the rate of harvest. Procedures used in valuating resident fisheries under this method are presented in Figure 4. The size of harvestable fish and maximum number in an allowable harvest would be dependent upon a number of factors which include species, hatchery versus wild fish recruitment, growth capabilities related to habitat and management goals. The area for which the population estimate is made would be dependent upon the scope of the economic analyses. Rate of harvest would be the average catch rate for angling under the given conditions or it could be a predetermined rate based on species management goals. The procedure is based on the premise that population structure will determine number of fish which could be harvested and rate of catch will provide an estimate of the time needed to remove these fish from the fishery. The value of a user day can be applied to the time needed to exploit the fishery with the resulting value being a potential value of the fishery.

This approach is more realistic in application to assessment of fishery values than would be valuation based on present use levels, especially in cases where habitats containing resident species are under utilized by anglers, and population structure indicates ample fish to sustain much heavier utilization. Also, population estimates are easier and more readily obtained than are estimates of total harvest and rate of catch.

A second method of resident fishery valuation would be based on cost of replacement. The method has been successfully used to mitigate

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FIGURE 3

Total Estimated Harvest

÷

Rate of Catch

=

Total Hours Fish

÷

Hours in Angler-Day

=

Total Number of Angler Days

x

Value of Angler Day

=

Total Value of Fishery

9

FIGURE 4

Number of Harvestable Sized
Fish in Population

x

Percent Targeted For
Harvest

=

Total Number to be
Harvested

÷

Rate of Catch

=

Time Needed to Remove
Fish

÷

Hours in Angler-Day

=

Total Number of Angler-Day

x

Value of Angler-Day

=

Total Value of Fishery

fishery losses resulting from water pollution (Pfeiffer, 1975).
Values are based on hatchery production costs and represent the
average purchase price of each fish at the hatchery. Use of this
method may be warranted if resulting impacts necessitate utilization
of hatchery reared fish to maintain a particular fishery. An example
would be if spawning and/or rearing habitats were impaired and
stocking of catchable fish would be necessitated to meet increased
angling demand. This value could be used separately or adjusted to
the value of the user days the fishery would support.

APPLICATION OF FISHERY VALUES TO RANGELAND MANAGEMENT

Forest rangelands encompass 1.2 billion acres in the 48 contiguous
United States, 622 million acres of which are found in the western
states. Livestock were grazed on 834 million of these acres during
1970 (Meehan and Platts, 1978). The actual use on these land areas
amounted to 213 million animal unit months. These same land areas
contain thousands of aquatic habitats, both streams and lakes, which
support a variety fish species. This combination of two high-value
resources existing on the same unit of land and competing for manage-
ment attention sets the stage for management conflicts.

Livestock grazing has been shown to exert adverse environmental
impacts on aquatic habitats (Moore, 1976; Gifford, 1975; Gunderson,
1968; Marcuson, 1971; Duff, 1977; Claire and Storch, 1977). Methods
to minimize adverse impacts have produced results with varying
degrees of success (Keller et al., 1978; Kimbal and Savage, 1977;
Duff, 1977 and others). Most of the methods reviewed require more
complex grazing management practices and increased costs. The
question which the land manager must address is whether increased
cost of protecting or enhancing aquatic habitats on forest rangelands
can be justified through use of more complex, sophisticated, and/or
costly rangeland practices. Utilization of dollar resources to
protect aquatic resources on livestock allotments would be justified
on the basis of: (1) high economic values associated with fisheries;
(2) compliance with Federal and State direction to protect aquatic
resources, and (3) implementation of range management techniques
producing positive benefits to both fisheries and livestock production.

Anadromous Species Application

An example of how anadromous fishery values can be incorporated into
allotment economic analyses is demonstrated in the Upper Hayden Creek
C&H Allotment, Leadore District, Salmon National Forest. The basic
approach follows the application given for fishery and timber values
on Forest lands in Oregon.[2] This allotment lies in the upper reaches
of Hayden Creek drainage and supports 1500 animal unit months of
livestock grazing. The Hayden Creek drainage also provides prime

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2 Presented in draft report prepared by Fred H. Everest, Research
   Fishery Biologist, Forest Service, Corvallis, Oregon.

habitat for anadromous and resident fish. Bear Valley Creek, tributary
to Hayden Creek, passes through the allotment and contains a section
of stream with ideal spawning habitat for anadromous fish. Spawning
habitat found within this stream reach is capable of supporting
approximately 100 salmon and steelhead redds, respectively. This
same section of stream has a meadow area of approximately 100 acres
of suitable range capable of supporting 31 animal unit months annually.[3]
Past livestock management of the allotment was associated with a four
pasture rotational system. The unit containing most of Bear Valley
Creek allowed unrestricted grazing of the meadow area when livestock
were scheduled in the unit. The intensified utilization of the area
by livestock caused damage to the aquatic and streamside areas within
the meadow.

An economic assessment of the Upper Hayden Creek allotment management
should include review of values associated with both livestock and
fisheries (Table 3). This would be particularly important for developing
management alternatives for the meadow area related to protecting
fishery values. The figures included in Table 3 reflect <u>direct</u> cash
flows of realizable costs and benefits. There are two major decisions
to be made when analyzing the data. First – what is the baseline
situation or what is the standard against which the alternatives will
be analyzed? Imbedded in this decision is a clear understanding of
the intent of the economic analysis. The second major decision would
be determining the valid costs and benefits (including opportunity
costs or cost and benefits forgone) to be included in the analysis.
This decision is dependent upon the type of analysis ("zero base" or
"marginal") which is applied. Discussion of the analysis procedures
will be addressed later in an example review. The 100 acre meadow
area would have an annual $246.14 forage value based on an estimated
capacity of 31 animal unit months valued at $7.94 per animal unit
month.[4] From the fisheries standpoint, the economic value of the
spawning and rearing habitat would be tied to the value of species
which utilize the spawning and rearing habitat. In the case of the
meadow area on Bear Valley Creek, the estimated value of escaping
salmon to the spawning area would be $6,720[5] for 1978 based on 14
chinook salmon redds being observed in this stream section. Values
attributed to steelhead trout would likely be double those of salmon
because of the nature of the stream and species escapement levels.

A point of clarification should be addressed, two critical habitat
variables can be associated with spawning habitat – quantity and
quality. The quantity of available habitat will determine the
maximum number of redds that can be physically constructed in an
area. The quality of the habitat will reflect upon the survival of

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3 Environmental Analysis Report – Bear Valley Creek Watershed and
   Fisheries Rehabilitation Project, Leadore Ranger District, Salmon
   National Forest, 1978.

4 Based on Water Resources Council (1973)

5 This value was determined using species values from Tuttle et al.,
   (1975) and an average of 2.4 fish being present in the stream for
   each redd constructed.

TABLE 3. -- Benefits and costs associated with management alternatives for the Bear Valley Creek portion of the Upper Hayden Creek Allotment. Values include only those attributed to anadromous species. All values expressed are annually incurred, except for fence construction which would be a one time cost.

| | Management Alternatives | | |
	Current Situation	Controlled Grazing	No Grazing
Benefits			
Range Value (31 AUM's)	246/yr.	185/yr.	0/yr.
Anadromous Fishery Value	20,160/yr.	30,240/yr.	40,320/yr.
Costs			
Allotment Management	500/yr.	500/yr.	400/yr.
Fence Construction[1]	-	5,000	5,000
Fence Maintenance	-	150/yr.	150/yr.

1 Range improvement techniques would not be strictly limited to fencing; other techniques such as salting, water development, herding, etc., could be used.

the eggs deposited in each redd. A similar relationship would exist between numbers and survival of fish and rearing habitat quantity and quality. The meadow area in Bear Valley Creek had 14 salmon redds observed during surveys conducted in 1978. Even though this level is only 14% of the estimated optimum utilization, the spawning habitat quality needed to maximize survival in the 14 redds would be comparable to that quality necessary to maximize egg survival in 100 salmon redds. Therefore it is consistant that management direction be toward maximizing survival through habitat quality protection and enhancement in addition to maintaining quantity. The lost fishery value in Bear Valley Creek resulting from the intensified level of grazing was unknown but impacts expressed as bank instability, reduction of bank cover, and sedimentation were evident. The decision facing the land manager was how to manage the land under multiple use guidelines and maintain the integrity of the dominant resources. Examination of the resource values of both range and anadromous fisheries habitat using somewhat hypothetical conditions may help to answer the question.

As was previously mentioned, benefit-cost analysis of management alternatives can be handled in one of two ways - the "zero base" approach or the "marginal" approach.

Under the "zero base" approach only direct costs and benefits displayed in Table 3 are valid in the analysis. Benefits and costs received annually were discounted at a rate of 10% and a planning horizon of 20 years was used in every case. Results of this analysis would be:

Current Situation:

PV_b (Present Value - benefits) = \$246 x 8.51 (constant) + \$20,160 x 8.51
= \$173,655.

$$\text{Note: Constant} = \frac{1 - \frac{1}{(1.1)^{20}}}{0.1} = 8.51$$

PV_c (Present Value - costs) = 500 x 8.5
= 4,255

PNW (Present Net Worth) = Present Value-Benefits - Present Value-Costs
= 173,655 - 4,255
= 169,400

B/C (Benefit/Cost) = 173,655/4,255
= 40.81

Controlled Grazing

PV_b (Present Value-benefit) = 185 x 8.51 + 30,240 x 8.51
= 258,916

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PV_c (Present Value-cost) $\quad = 5,000 + 500 \times 8.51 + 150 \times 8.51$
$\quad = 10,532$

PNW (Present Net Worth) $\quad$ = Present Value-benefits − Present Value-costs
$\quad = 248,384$

B/C (Benefits/Cost) $\quad = 258,916/10,532$
$\quad = 24.58$

No Grazing

PV_b (Present Value-benefit) $= 40,320 \times 8.51$
$\quad = 343,123$

PV_c (Present Value-costs) $\quad = 5,000 + 400 \times 8.51 + 150 \times 8.51$
$\quad = 9,681$

PNW (Present Net Worth) $\quad = 343,123 - 9,681$
$\quad = 333,442$

B/C (Benefit/Cost) $\quad = 343,123/9,681$
$\quad = 35.44$

The "marginal" approach differs in that comparisons are made only between
alternatives which differ from the current situation. Changes in the
benefits or costs under each alternative become the valid quantities for
use in the analysis. Results of this analysis would be:

Controlled Grazing:

Additional Benefits

Estimated increase in Fishery Value $\qquad$ $10,080/yr.

Additional Costs

Fence Construction $\qquad$ $ 5,000
Fence Maintenance $\qquad$ $ 150/yr.
AUM's Forgone $\qquad$ $ 61/yr.

PV_b (Present Value-benefit) $= 10,080 \times 8.51$
$\quad = 85,781$

PV_c (Present Value-costs) $\quad = 5,000 + 150 \times 8.51 + 61 \times 8.51$
$\quad = 6,796$

PNW (Present Net Worth) $\quad = 85,781 - 6,796$
$\quad = 78,985$

B/C (Benefit/Cost) $\quad = 85,781/6,796$
$\quad = 12.62$

No Grazing:

Additional Benefits

Estimated Increase in Fishery Value $ 20,160/yr.
Reduction Allotment Management Cost   100/yr.

Additional Costs

Fence Construction $ 5,000
Fence Maintenance   150/yr.
AUM's Forgone   246/yr.

PV_b (Present Value-benefits) = 20,160 x 8.51 + 100 x 8.51
                                 = 172,413

PV_c (Present Value-costs)   = 5,000 + 150 x 8.51 + 246 x 8.51
                                 = 8,370

PNW (Present Net Worth)   = 172,413 - 8,370
                                 = 164,043

B/C (Benefit/Cost)   = 172,413/8,370
                                 = 20.60

Both approaches are valid if correctly applied. Therefore, the most
important aspect is the interpretation of results. Summarization of the
calculations from both approaches are presented in Table 4.

TABLE 4. -- Comparison of present net worth and benefit-cost calcula-
            tions derived from "zero base and "marginal" analytical
            approaches.

	"Zero Base"		"Marginal"	
	PNW	BC	PNW	B/C
Current Situation	$169,400	40.81	–	–
Controlled Grazing	$248,384	24.58	$ 78,985	12.62
No Grazing	$333,442	35.44	$164,043	20.60

It is important to remember that the intent of the analysis was to compare the controlled and no grazing alternatives to the present management situation and to assess which (if either) would be economically better. To do so using the "zero base" approach, the PNW and B/C calculations for each alternative must be compared to the PNW and B/C of the current situation.

If they are greater, then the alternative would be better. Notice that in this example that the B/C calculation for the current situation was greater than those B/C calculated under controlled and no grazing. The converse was true for present net worth calculations for the three management situations with both alternatives having values higher than the present situation. These differences can be attributed to the reduced investment involved in the present situation.

In using the "marginal" approach you need only consider whether present net worth and B/C calculations for the alternatives are > 0 and the B/C > 1. This is because comparison to the base situation was implicit in the analysis. Since the present net worth and B/C calculations for both the controlled and no grazing alternatives meet this criteria we can conclude that both are better than the current situation. It can also be concluded that the no grazing alternative would be more economically effective. Because of the inherent nature of most land management analyses, the "marginal" approach would be best adapted to provide the needed comparisons. Most analyses would be aimed at comparing custodial management in existance to proposed management changes. It is therefore recommended that the "marginal" approach be used to evaluate allotment management alternatives.

In applying economic analysis results from Bear Valley Creek, the land manager is faced with deciding which management strategy best meets the needs of the resources in question and land management goals and objectives. As was shown in the "zero base" alternative, all management alternatives had positive B/C calculations indicating that all would be cost effective. Further review using the "marginal" approach indicated that both alternatives were better than the current situation.

The most cost efficient option in the case of rangeland management of the meadow area on Bear Valley Creek, would be curtailment of grazing to preserve anadromous fishery values. Even though the alternative designed to allow for restricted grazing did not produce a benefit/cost ratio as high as that associated with complete livestock removal, it could be expected to produce economic values over that expected under the current management situation and could present a more acceptable option to both the manager and users. The example of Bear Valley Creek meadow represents a typical situation in which anadromous fishery values may be useful in aiding the land manager during the decision-making process. It is probable that allotments, such as Upper Hayden Creek, containing streams with anadromous fisheries will prove to be very high value resource areas justifying implementation of rangeland management options aimed at protecting the aquatic resource.

Resident Species Application

Resident fish habitats comprise the bulk of aquatic habitats in the Intermountain area and these habitats are most likely to be effected by rangeland management decisions. Resident fish habitats cover a wide spectrum of habitat types ranging from small mountain streams to large lowland rivers and small mountain lakes to large impoundments. Application of resident fishery values from a small stream can be demonstrated by analysis of the Seven-Mile Creek C&H Allotment, Fishlake National Forest. Here again the alternatives discussed in the example contain somewhat hypothetical responses relative to livestock-fishery interactions and the resulting benefits and costs.

The Seven-Mile C&H Allotment contains Seven-Mile Creek which is managed as a wild trout fishery by Utah State Division of Wildlife Resources. Past studies of fish population structure and fisherman use indicated that 11,640 fish were estimated to reside within the stream. A creel census conducted on Seven-Mile Creek during the summer of 1975 estimated that 3,350 fish were harvested at an average catch rate of 0.82 fish per hour.[6] In the case of Seven-Mile Creek the actual angler use was used to develop the annual fishery values expressed in Table 5. Management of the grazing resource of the allotment has been designed to handle 5,071 animal unit months through the use of four units grazed on a rest rotation system.[7] The fencing system is such that 3/4 of stream area within the allotment would be subjected to livestock grazing on any given year. A livestock exclosure constructed in the upper stream area provided some tentative information relative to specific impacts of livestock grazing on aquatic habitat and the dependent fish population. Stream features protected by the exclosure were of noticeably higher quality than similar features in grazed meadow areas. Fish of sizes larger than seven inches were also in greater abundance within the exclosure. Results from other studies previously cited have shown that fish populations are from 2-4 times greater in ungrazed areas when compared to grazed stream sections. The exact extent to which grazing has impacted fish populations in Seven-Mile Creek is unknown but it would be reasonable to believe that populations were approximately half of what they would be under no grazing.

Application of the range and fishery values (Table 5) using the "marginal" approach would be as follows:

Controlled Grazing

Additional Benefits:
  Expected increase in fishery value   5,447/yr.

Additional Costs:
  Fence Construction   50,000
  Fence Maintenance   1,500/yr.
  AUM's Forgone   214/yr.

6 Dale Hepworth, Utah Div. Wildl. Res., Cedar City, Utah
7 Victor Staroskta, Fishlake Nat'l. Forest, Richfield, Utah

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TABLE 5. -- Benefits and costs associated with management alternatives
for Seven-Mile Creek, Fish Lake National Forest. Values
expressed are annually incurred, except for fence construc-
tion which would be a one time cost.

| | | Management Alternatives | |
	Current Situation	Controlled Grazing	No Grazing
Benefits			
Range Values	428	214	0
Resident Fishery Values	6,808	12,255[1]	13,618
Costs			
Allotment Management	500	500	400
Fence Construction		50,000[2]	50,000
Fence Maintenance		1,500	1,500

1 Reflects a 10% in fishery values below values expected under no grazing.

2 Cost of 10 miles of fence needed to provide a 300 foot wide buffer zone
or pasture.

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PV_b (Present Value-benefits) $\quad = 5,447 \times 8.51$
$\qquad\qquad\qquad\qquad\qquad\qquad = 46,354$

PV_c (Present Value-costs) $\quad = 50,000 + 1,500 \times 8.51 + 214 \times 8.51$
$\qquad\qquad\qquad\qquad\qquad\qquad = 64,586$

PNW (Present Net Worth) $\qquad = 46,354 - 64,586$
$\qquad\qquad\qquad\qquad\qquad\qquad = -18,232$

B/C (Benefit/Cost) $\qquad\qquad = 46,354/64,586$
$\qquad\qquad\qquad\qquad\qquad\qquad = 0.71$

No Grazing

Additional Benefits:
Expected increase in fishery value $\qquad$ \$ 6,810/yr.
Reduction in allotment management cost $\qquad$ \$ 100/yr.

Additional Costs:
Fence Construction $\qquad\qquad\qquad\qquad$ \$50,000
Fence Maintenance $\qquad\qquad\qquad\qquad$ 1,500/yr.
AUM's Forgone $\qquad\qquad\qquad\qquad\qquad$ 428/yr.

PV_b (Present Value-benefits) $\quad = 6,810 \times 8.51 + 100 \times 8.51$
$\qquad\qquad\qquad\qquad\qquad\qquad = 58,804$

PV_c (Present Value-costs) $\quad = 50,000 + 1,500 \times 8.51 + 428 + 8.51$
$\qquad\qquad\qquad\qquad\qquad\qquad = 66,406$

PNW (Present Net Worth) $\qquad = 58,804 - 66,407$
$\qquad\qquad\qquad\qquad\qquad\qquad = -7,603$

P/C (Benefit/Cost) $\qquad\qquad = 58,804/66,407$
$\qquad\qquad\qquad\qquad\qquad\qquad = 0.89$

As indicated by the analysis, present net worth and benefit-cost calcu-
lations for both alternatives do not on the surface meet the criteria
necessary to conclude that either would be "economically better" than
the present situation. In this example the land manager does not have
the option of selecting between alternatives which provide an economic
advantage over the present situation. If protection of the fishery
would still be desirable, further evaluation of the situation to provide
an acceptable management direction would be needed. In the case of
Seven-Mile Creek, several obvious options would provide the needed cost
relief. The first option might be to work on reducing fencing costs
through the use of man-power programs (i.e. CETA, YACC, YCC, Volunteers,
etc.) and/or limiting the amount of fencing to the most sensitive areas.
Other options might include refinement of grazing systems or changes in
livestock class.

As can be seen in the example, fencing may not provide an "economically justified" solution to grazing management problems in all areas. This may be especially true on small streams, similar to Seven-Mile Creek, having populations sustained through natural reproduction and supporting relatively light angler-use. In these cases where fencing can not be justified for economic reasons, application of other less costly range management techniques may be necessary to meet management objectives to protect fishery values. Other alternatives to management of streamside areas could include development of water away from stream channels, adjusted salting to draw livestock to higher areas, and increased herding to keep livestock distributed more evenly over the allotment thus reducing over use in the streamside area. Intensified herd management associated with culling of those individuals which habitually spent prolonged periods in riparian areas could also prove beneficial in reducing conflicts within streamside areas. The kinds of alternatives available to the land manager are as varied as the lands managed. Solutions to resource conflicts within riparian zones will require objectivity, careful planning, and consideration of many alternatives. Use of fencing to correct livestock management problems in riparian zones should not be considered as a panacea. Fencing as an alternative discussed in the report was included to provide easily followed examples of how economic analyses can include values and costs of resources other than grazing.

It should be noted that in the Seven-Mile Creek example that two constraints were applied to the analysis that may not have adequately or justly represented the actual condition. The first was that the fish population would likely double as a result of removal of the negative influence from grazing. It is very conceivable that a population increase could be as much as four times higher. This would drastically effect the outcome of the economic analysis by making both controlled and no grazing "better economically" than the present situation. The second constraint related to the length of an angler-day which was set at 12 hours (consistant with the length of a recreation visitor day). In actuality, the length of an angler-day would likely be much less. When subjecting the values in the example to a reduction in the length of an angler-day (reduced to 10 hours) the analysis would indicate that no grazing would present a viable economic option.

The two examples mentioned represent typical situations that may exist on many rangelands in the west. The depth to which economic analyses were taken is admittedly cursory but they do demonstrate that knowledge of fishery values can be applied to making management decisions. Protection or enhancement of fishery values and entering the associated costs and benefits into economic analyses may prove useful in selecting rangeland management alternatives which reduce negative impacts and focus on total rangeland resource management.

CONCLUSIONS

Forest rangelands encompass a number of diversified resources including livestock grazing and fisheries habitats and while these resources are managed concurrently they do not always receive the attention justified by their economic importance. Fishery values have generally been overlooked during the economic analyses of range allotments and the result has been demonstrated by serious negative impacts to many aquatic environments. Inclusion of fishery values into the allotment analysis procedure may show justification for implementation of more specific and complex range management alternatives designed to protect aquatic environments.

It is not realistic to assume that economic values of livestock grazing and fisheries are the only resource values upon which to base rangeland decisions. The complete decision-making process should include consideration of all resource values including range, fisheries, soils, watershed, wildlife, and recreation. It is, however, realistic to consider that many resource decisions are based on either known or perceived economic values. By including estimates of fishery values into the rangeland decision-making process a more balanced program should result.

LITERATURE CITED

Brown, W. G., A. Singh, and E. N. Castle. 1964. An economic evalua-
tion of the Oregon salmon and steelhead sport fishery. Oregon
Agric. Exp. Stn. Tech. Bull. 78. 47 pp.

Brown, W. G., A. K. Singh, and J. A. Richards. 1972. Influence of
improved estimating techniques on predicted net economic values
for salmon and steelhead. Oreg. St. Univ., Agric. Exp. Stn.,
Corvallis, Oreg. 23 pp.

Claire, E. W. and R. L. Storch. 1977. Streamside managements and
livestock grazing – an objective look at the situation. Livestock
and Wildl.-Fish. Workshop. Reno, Nev. 57 pp.

Clawson, M. 1976. The economics of National Forest Management.
RFF Working Paper EN-6, John Hopkins Press. 117 pp.

Daily, M. 1975. Oregon salmon and steelhead catch data, 1965-1974.
Oreg. Dep. Fish and Wildl., Fish. Div., Portland, Oreg. 8 pp.

Duff, D. A. 1977. Livestock grazing impacts on aquatic habitat in Big
Creek, Utah. Livestock and Wildl.-Fish Workshop. Reno, Nev. 15 pp.

Everest, F. H. 1975. An economic evaluation of anadromous fishery
resources of the Siskiyou National Forest, Grants Pass, Ore. 23 pp.

Everest, F. H. 1977. Evaluation of fisheries for anadromous salmonids
produced on western National Forest. Fisheries 2(2):8-11 and 34-36.

Gifford, G. 1975. Beneficial and detrimental effects of range improve-
ment practices on runoff and erosion. In Proc., Watershed Manage.
Symp. Am. Soc. Civil Eng. p. 216-274.

Gordon, D., D. W. Chapman, and T. C. Bjorn. 1973. Economic evaluation
of sport fisheries – what do they mean? Trans. Am. Fish. Soc.
102(2):293-311.

Gunderson, D. R. 1968. Floodplain use related to stream morphology
and fish populations. Journ. Wildl. Mgmt. 32(3): 507-514.

Hansen, C. S. 1977. A report on the value of wildlife (Wildlife Economics).
U. S. Dep. Agric., Forest Service, Int. Mtn. Reg. 23 pp.

Keller, C., L. Anderson, and P. Tappel. 1978. Fish habitat changes
in Summit Creek, Idaho, after fencing the riparian area. In:
"Forum" Grazing and Riparian/Stream Ecosystems. Trout Un-
limited. 26 pp.

Kimbal, J. and F. Savage. 1977. Diamond Fork aquatic and range habitat improvement. U. S. Dept. of Agric., Forest Service, Inter. Mtn. Reg. 19 pp.

Kunkel, C. and P. Janik. 1976. An economic evaluation of salmonid fisheries attributable to Siuslaw National Forest. Siuslaw Nat'l. Forest, Corvallis, Oreg. 21 pp.

Marcuson, P. 1971. South central Montana fisheries study, Rock Creek floodplain study. Prog. No. F-20-R-14, Mont. Fish and Game Dept., Helena, Mont. 4 pp.

Mathews, S. B. and G. S. Brown. 1970. Economic evaluation of 1967 sport salmon fisheries of Washington. Wash. Dep. Fish., Tech. Rep. No. 2, Olympia, Wash. 19 pp.

Meehan, W. R. and W. S. Platts, 1978. Livestock grazing and aquatic environment. Journ. of Water Cons. 33(6):274 - 278.

Moore, E. 1976. Livestock grazing and protection of water quality. Working paper. EPA, Washington, D. C. 123 pp.

Pfeiffer, P. W. 1975. Monetary values of fish. Pollution Committee, Southern Div., Am. Fish. Soc., 18 pp.

Reed, P., R. McQueen, and M. Zirges. 1975. Management of the troll salmon fishery. Fish Comm. of Oreg., Div. of Mgmt. and Res. Ann. Rep. 18 pp.

Sayre, R. 1972. 1972 Oregon angler survey, Summary. Oreg. St. Game Comm., Portland, Oreg. 13 pp.

Tuttle, M. E., J. A. Richards, and R. J. Wahle. 1972. Partial net economic values for salmon and steelhead for the Columbia River system. U. S. Pop. of Commer., NOAA, NMFS. 22 pp.